

E1 - PHYSICS Practical (NA)

By:

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Date:

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“The Power and Temperature of the Sun”

Syllabus section: E2 (Stellar Radiation)

AIM

In many situations it is impossible to measure something directly. This experiment is a clever example of how to use physics theory, and some mathematics, to measure indirectly, what is impossible to do directly - namely to find the power and temperature of the sun.

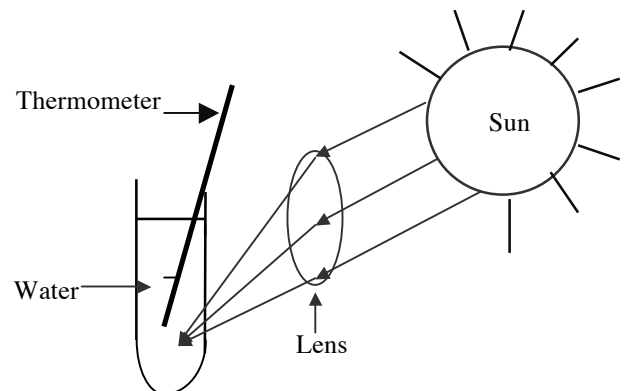
APPARATUS

Magnifying glass, Thermometer

Test tube, Stopwatch.

METHOD

1. Measure the mass of the water.
2. Take the temperature of the water.
3. Focus the sun on to the water and stir occasionally.
4. Measure the time it takes to heat up the water X degrees.
5. Hold the lens and test tube steady until the water has increased in temperature a reasonable amount. *Note: do not allow the water to boil!*
6. Find the energy absorbed by the water using: $Q = m \times c \times \Delta T$, where m is the mass of the water and c the specific heat capacity (4.2 J/g/K) and ΔT the temperature increase
7. Measure the surface area of the lens



THEORY

The energy that passes through the lens heats the water and the test tube. This energy can be calculated using the equation for specific heat capacity. This is the energy passing through area A m^2 of the lens. Knowing distance to the Sun ($= 1.5 \times 10^{11} \text{ m}$), you can calculate the total Energy emitted by the Sun. Dividing this energy by the number of seconds it took to heat up the water, you will get the power of the Sun (This is actually called L , the luminosity). The surface temperature of the Sun can be calculated by using the “Stefan - Boltzmann” equation:

$$L = 4\pi R^2 \times 5.67 \times 10^{-8} \times T^4$$

With L is the Luminosity (or Power) of the Sun, R is the radius of the Sun (695,000,000 m) and T the surface temperature of the Sun (in Kelvin). The numerical value is Stefan-Boltzmann’s constant σ .

YOUR TASK

- ☐ Collect data that will allow you to calculate the surface temperature and power of the sun.
- ☐ Using the above method and theory, calculate the surface temperature and power of the sun.
- ☐ The true value for the power of the Sun is $3.9 \times 10^{26} \text{ W}$.
- ☐ The true value for the temperature of the Sun is 5800 K
- ☐ There are many faults in this experiment. Try to think of some of them.
- ☐ Submit one A4 paper (written or typed), including:
 - Your raw data (in a table) – 2 marks
 - Your calculations (Energy, Surface Area, Power, etc.) – 4 marks
 - Your results (Power of the Sun and Temperature of the Sun) – 4 marks
 - The percentage errors (comparison of experimental versus real value) – 2 marks
 - Two reasons for the given uncertainty / errors – 2 marks
- ☐ Your ‘report’ will be graded, not against the PSOW criteria, but simply by getting a grade (out of 7). The total number of marks is 14, and your grade can be calculated by dividing the received marks by two.